IN THE SPECIFICATION:

Please substitute the following paragraph for the paragraph starting at page 1, line 13 and ending at line 19. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a1

--The density of an integrated circuit increases more and more, and the specification and performance required for a projection (exposure) optical system become much stricter. Generally, in order to obtain a higher resolving power, the exposure wavelength is shortened and/or the numerical aperture (NA) of a projection optical system is enlarged.--

Please substitute the following paragraph for the paragraph starting at page 1, line 20 and ending at page 3, line 4. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a2

--However, as the exposure wavelength reaches a region of 193 nm (Arf excimer laser light) or 157 nm (F_2 excimer laser light), usable lens materials are limited to quartz and fluorite. This is mainly because of decreases of the light transmission factor. For example, in a projection optical system such as disclosed in Japanese Laid-Open Patent Application, Laid-Open No. 79345/1998, wherein it comprises all dioptric lenses of a large number and wherein all lenses have a large glass material thickness, the exposure amount on a wafer becomes low and it causes a decrease of the throughput. Also, due to thermal absorption by the lenses, there occur problems (thermal aberration) such as changes of aberration or shift of the focal point position. When the exposure wavelength is 193 nm, quartz and fluorite can be used as a projection optical system. However, because the difference in dispersion between them is not large, correction of chromatic aberration is difficult to accomplish. In order to correct the chromatic aberration of a

projection optical system completely, it is necessary to use a few achromatic lenses having a small curvature radius at its achromatic surface. This leads to an increase of the total glass material thickness of the optical system, which then raises the above-described problems of thermal aberration and transmission factor. Further, currently, it is very difficult to produce a projection optical system by use of fluorite, having a sufficient property to assure its design performance. It is further difficult to produce one having a large diameter. This makes it very difficult to accomplish color correction, and results in an increase of the cost. As for the exposure wavelength of 157 nm, only fluorite is the usable lens material. The chromatic aberration cannot be corrected only with a single lens material. Anyway, it is very difficult to provide a projection optical system only by use of dioptric systems.--

a2 cont

Please substitute the following paragraph for the paragraph starting at page 3, line 20 and ending at page 4, line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--When a projection optical system which includes a catoptric system to meet the shortening of the exposure wavelength and the enlargement of NA (numerical aperture) is produced, the structure should of course be one that enables correction of chromatic aberration. In addition, idealistically, the structure should be simple and sufficient to enable that an imaging region of sufficient size is defined upon an image plane, that the number of optical elements such as mirrors or lenses is small, that the mirror incidence angle and reflection angle are not large, and that a sufficient image-side working distance is assured.--

a3

Please substitute the following paragraph for the paragraph starting at page 4, line 6 and ending at page 5, line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

If an imaging region width of sufficient size is attainable on the image plane, in the case of scan type projection exposure apparatus, it is advantageous with respect to the throughput, such that the exposure variation can be suppressed. If the number of optical elements is small, the process load in the production of optical elements such as mirrors and lenses can be reduced. Also, since the total glass material thickness can be made smaller, the loss of light quantity can be reduced. Further, the increase of the footprint of the apparatus can be suppressed, and the loss of light quantity due to the film can also be decreased. Particularly, this is very advantageous because, when the exposure wavelength is 157 nm (F_2 excimer laser light), the loss of light quantity at the mirror reflection film cannot be disregarded. When the mirror incidence angle and the reflection angle are not large, the influence of a change in light quantity due to the angular characteristic of the reflection film can be suppressed. If a sufficient image-side working distance can be maintained, it is advantageous with respect to structuring an autofocusing system or a wafer stage conveyance system in the apparatus. If the structure is simple, complicatedness of a mechanical barrel, for example, can be avoided, and it provides an advantage to the manufacture.

a4

Please substitute the following paragraph for the paragraph starting at page 5, line 6 and ending at line 7. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a5 Here, the conventional examples are considered with respect to the above-described points.

Please substitute the following paragraph for the paragraph starting at page 5, line 8 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a6 In the projection optical system shown in U.S. Patent No. 5,650,877, a Mangin mirror and a refracting member are disposed in an optical system to print an image of a reticle on a wafer. This optical system has inconveniences that, in every picture angel used, there occurs light interception (void) at the central portion of a pupil and that the exposure region cannot be made large. If the exposure region is to be enlarged, it disadvantageously causes widening of the light interception at the central portion of the pupil. Further, the refractive surface of the Mangin mirror defines a beam splitting surface such that the light quantity decreases to a half each time the light passes this surface. The light quantity will be decreased to about 10% upon the image plane (wafer surface).

Please substitute the following paragraph for the paragraph starting at page 5, line 24 and ending at page 6, line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a7 In the projection optical systems shown in Japanese Laid-Open Patent Applications, Laid-Open Nos. 211332/1997 and 90602/1998, the basic structure comprises a reflection system only. However, with respect to aberration (Petzval sum) and mirror disposition, it is difficult to keep a sufficient imaging region width on the image plane. Also,

since, in this structure, a concave mirror adjacent to the image plane and having a large power mainly has an imaging function, enlargement of NA is difficult to accomplish. Since a convex mirror is placed just before the concave mirror, a sufficient image-side working distance cannot be maintained.--

A7 cont

Please substitute the following paragraph for the paragraph starting at page 6, line 24 and ending at page 7, line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--In the projection optical systems shown in Japanese Laid-Open Patent Applications, Laid-Open Nos. 163319/1988, 188298/1993 and 230287/1994, the structure is complicated due to deflection and bend of the optical path. Since most of the power of optical groups for imaging an intermediate image, as a final image, is sustained by concave mirror, it is structurally difficult to enlarge the NA. The magnification of the lens system which is disposed between the concave mirror and the image plane is at a reduction ratio and also it has a positive sign. Because of it, a sufficient image-side working distance cannot be kept. Further, in order that the object plane and the image plane are placed opposed, it is necessary to use two flat mirrors only for the sake of deflection of the optical path, without any contribution to aberration correction. As the exposure wavelength is shorted to 157 nm, this is undesirable also with respect to the loss of light quantity. Further, it is structurally difficult to hold the imaging region width because of the necessity of light path division. Since the optical system has to be large, there is a disadvantage with respect to the footprint.--

A8

Please substitute the following paragraph for the paragraph starting at page 7, line 21 and ending at page 8, line 10. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-In the projection optical systems shown in Japanese Laid-Open Patent Applications, Laid-Open Nos. 66510/1990 and 282527/1991, the optical path is divided by a beam splitter, and this makes the barrel structure complicated. It needs a beam splitter of large diameter and, if this is of a prism type, the loss of light quantity is large because of its thickness. For a larger NA, a larger diameter is necessary, and thus the loss of light quantity becomes larger. If the beam splitter is of a flat plate type, there will occur astigmatism and coma even in regard to axial light rays. Further, there may occur aberrations due to a change in characteristic at the light dividing surface or production of asymmetric aberration resulting from thermal absorption. It is therefore difficult to manufacture the beam splitter very accurately.-

a9

Please substitute the following paragraph for the paragraph starting at page 11, line 17 and ending at line 19. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-(13) A projection optical system according any one of Items (9) to (12), wherein said field optical system is constituted by lenses.-

a10

Please substitute the following paragraph for the paragraph starting at page 11, line 20 and ending at page 12, line 3. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-(14) A projection optical system according to any one of Items (9) to (12), wherein said field optical system comprises a first field mirror and a second field mirror group including a second field mirror, wherein abaxial light passed through the outside of the effective diameter of said first mirror group is reflected by said first field mirror and said second field mirror, in this order, and after that, the light passes a region adjacent to the optical axis of said first field mirror and enters said second imaging optical system.-

a11

Please substitute the following paragraph for the paragraph starting at page 12, line 4 and ending at line 7. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-(15) A projection optical system according to Item (14) wherein said first field mirror comprises a concave mirror and wherein said second field mirror comprises a convex mirror.-

a12

Please substitute the following paragraph for the paragraph starting at page 12, line 8 and ending at line 11. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-(16) A projection optical system according to Item (14) wherein said first field mirror comprises a concave mirror and wherein said second field mirror comprises a concave mirror.-

a13

Please substitute the following paragraph for the paragraph starting at page 15, line 7 and ending at line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a14

--(32) A projection optical system according to any one of Items (1) to (31), wherein said projection optical system has a magnification of a reduction ratio.--

Please substitute the following paragraph for the paragraph starting at page 17, line 13 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a15

--Figure 12 is a schematic view of a light path in a case, in Example of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 17, line 17 and ending at line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a16

--Figure 13 is a schematic view of a light path in a case, in Example 6 of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 17, line 21 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a17

--Figure 14 is a schematic view of a light path in a case, in Example 7 of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 17, line 25 and ending at page 18, line 1. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a18 --Figure 15 is a schematic view of a light path in a case, in Example 8 of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 18, line 2 and ending at line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a19 --Figure 16 is a schematic view of a light path in a case, in Example 9 of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 18, line 6 and ending at line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a20 --Figure 17 is a schematic view of a light path in a case, in Example 10 of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 18, line 10 and ending at line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a21 --Figure 18 is a schematic view of a light path in a case, in Example 11 of the present invention, wherein a field optical system is constituted by lens systems.--

Please substitute the following paragraph for the paragraph starting at page 18, line 14 and ending at line 17. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a22

Figure 19 is a schematic view of a light path in a case, in Example 12 of the present invention, wherein a field optical system is constituted by lens systems.

Please substitute the following paragraph for the paragraph starting at page 24, line 26 and ending at page 25, line 1. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a23

The refractive lens group R may be disposed in the group L2, including two mirrors, that is, the first and second mirrors M1 and M2.

Please substitute the following paragraph for the paragraph starting at page 25, line 7 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a24

When the refractive lens group R is disposed between the refractive lens group L1 and the first mirror M1, the structure is such as called a reciprocal optical system. Namely, into this refractive lens group R, the light refracted by the refractive lens group L1 enters and, additionally, the light reflected by the second mirror M2 passes therethrough. When this refractive lens group R is used, the refracting power thereof should desirably be negative. If the refracting power of the refractive lens group R is negative, the Petzval sum which the first mirror M1 bears is shared. Also, it contributes to correction of chromatic aberration in the whole system. Thus, if the refractive lens group R is provided, it should desirably have a negative

a24 cont'd

refracting power. Further, simultaneously, it contributes to correction of coma aberration and spherical aberration of the whole system.

Please substitute the following paragraph for the paragraph starting at page 25, line 25 and ending at page 26, line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a25

As described hereinbefore, mainly for correction of axial chromatic aberration or the like, the refractive lens group R should preferably be disposed about the first mirror M1. However, it may be disposed adjacent to the second mirror R. Namely, it may be disposed at a position for transmitting the reflection light from the first mirror M1 and the reflection light from the second mirror. Further, the refractive lens group R may be disposed at any place within the range of the group L2, including two mirrors. Also, lens elements of any number may be used.

Please substitute the following paragraph for the paragraph starting at page 26, line 10 and ending at line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a26

The projection optical system in this embodiment, particularly when it is provided by a double-imaging optical system, has a positive magnification.

Please substitute the following paragraph for the paragraph starting at page 26, line 21 and ending at page 28, line 4. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-In accordance with another embodiment of the present invention, a catadioptric projection optical system such as shown in Figure 3, for example, is provided (Second Embodiment). In this embodiment, the region of the object plane from which the light reaches the image plane and which is attributable to the imaging is a semi-arcuate zone (ring-like field) outside the optical axis, and there is no void at the central portion of the light upon the pupil plane. The projection optical system comprises, in an order along the optical path from the object side, a first imaging system Gr1 having a function for forming an intermediate image of the object, a field optical system Grf for projecting a pupil of the first imaging system Gr1 onto a pupil of a second imaging system Gr2, and the second imaging system Gr2 is disposed just before the image plane and operates to form a final image. The first imaging system Gr1 includes two mirror groups, i.e., a first mirror group Gm1 including a first mirror M1 and having a positive refracting power, and a second mirror group GM2 including a second mirror M2. The second mirror group GM2 is disposed physically at the object side of the first mirror group GM1, and the first mirror M1 is a concave mirror having its concave surface facing to the object side. The light from the object side is reflected by the first and second mirrors M1 and M2, in this order, inside the first imaging system Gr1. After this, the light goes through the outside of the effective diameter of the first mirror group GM1 toward the image side, and it passes through the field optical system Grf and the second imaging system Gr2. Thus, the whole system of the projection optical system is defined along a straight optical axis 103. The object plane and the image plane are opposed to each other, at the opposite ends of the optical axis 103. The magnification of the projection optical system is a reduction ratio.-

a21

Please substitute the following paragraph for the paragraph starting at page 28, line 5 and ending at line 15. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Figure 3 is a schematic view of a basic structure of the second embodiment, and Figures 12 - 45 show Examples 5 - 21, respectively, to which the second embodiment is applied, to be described later. In all examples, the first imaging system Gr1 has two mirrors, and the second imaging system Gr2 comprises refractive lens systems only. Figures 12 - 19 show cases wherein the field optical system Grf is provided by lens systems, and Figures 20 - 28 show cases wherein the field optical system Grf has two mirrors.--

a28

Please substitute the following paragraph for the paragraph starting at page 28, line 16 and ending at line 17. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Generally, when a mirror is used, the optical system functions as follows.--

a29

Please substitute the following paragraph for the paragraph starting at page 29, line 5 and ending at line 8. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Because of this, the optical system has to be complicated to place the object and image planes opposed to each other. For example, there occurs a void in the pupil, ring field, and bend of optical path.--

a30

Please substitute the following paragraph for the paragraph starting at page 29, line 9 and ending at page 30, line 19. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a31

In this embodiment, to accomplish the above-described purposes, the functions of a mirror such as described above are effectively reflected to the optical system. As shown in Figure 3, the structure is simple and the projection optical system is disposed along a straight optical axis 103, although it uses a first imaging system, a field optical system, a second imaging system and a mirror, as shown in Figure 3. This provides significant advantages. Since there is no necessity of bending the optical path, the barrel structure can be made simple like that of a conventional refractive lens system. As regards the self-weight deformation of an optical element, since the gravity direction and the optical axis direction are registered with each other, there does not occur asymmetrical deformation. Thus, an asymmetrical aberration does not occur easily. Current equipment for the manufacture, such as peripheral equipment for assembling and adjustment as well as instruments for measurement, for example, can be used. This is very advantageous with respect to the cost. Further, since the footprint of the apparatus is substantially the same as that of a conventional refractive lens system, the area to be occupied is unchanged. This feature is accomplished by the arrangement that, while an optical system concept (ring field system) in which only paraxial light contributes to the imaging, is set, the function (c) described above is used twice in the first imaging system Gr1, and double reflections are accomplished with the use of two mirrors, and that the light from the object side is directed through the outside of the effective diameter of the first mirror group GM1 to the image side. The light thereafter passes through the field optical system Grf and the second imaging system

a31 cont

Gr2, and it reaches the image plane. Thus, an optical system having a single optical axis is accomplished.

Please substitute the following paragraph for the paragraph starting at page 30, line 20 and ending at page 31, line 12. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a32

The second imaging system Gr2 is provided by refractive lens system, and it has a positive refracting power. With this structure, enlargement of the NA can be met and, additionally, the image side working distance can be assured easily. If the second imaging system Gr2 has a concave mirror, as described with reference to the conventional examples, it becomes difficult to enlarge the NA and to keep the image side working distance. The field optical system Grf may be provided by refractive lens systems, as shown at (A) in Figure 3. Alternatively, it may comprise two mirrors, such as shown at (B) in Figure 3. As will be described later in relation to examples, depending on the power arrangement, the positive lens FL1 may be omitted. In the case of (B) in Figure 3, the field optical system Grf includes a first field mirror FM1, comprising a concave mirror, and a second field mirror FM2, comprising a convex mirror. The second field mirror may be provided by a concave mirror.

Please substitute the following paragraph for the paragraph starting at page 31, line 13 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a33

As regards the color correction, the achromatic state of the first imaging system Gr1 may be made "over achromatism" on the basis of the function (a) described above,

when the first mirror group GM1 is constituted by a lens LN1 of negative refracting power as well as the first mirror M1 which is a concave mirror. Thus, even though a single glass material is used for the lens, correction of chromatic aberration can be attained. This is very advantageous particularly for use of an Arf excimer laser or an F_2 excimer laser.-

a33 cont

Please substitute the following paragraph for the paragraph starting at page 33, line 19 and ending at page 34, line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-As regards the incidence angle and reflection angle of light on the mirror, because this embodiment concerns a ring field system, because this embodiment concerns a ring field system, the incidence angle and the reflection angle of the light on the mirror can be made smaller than that in an optical system of a Cassegrain type or Schwarzschild type. Further, in the first imaging system Gr1, the first mirror M1 is disposed adjacent to a point optically conjugate with a pupil, and the light reflected by the second mirror M2 passes about the outside of the effective diameter of the first mirror group GM1. Since the light is not reflected at a high position away from the optical axis of the mirror, the incidence angle and the reflection angle of the light on the first and second mirrors M1 and M2 do not become extraordinarily large. In a case where the field optical system Grf has a structure as shown at (B) in Figure 3, the spacing between the first and second field mirrors FM1 and FM2 is kept large as much as possible. Also, the width of light is narrow. Therefore, the incidence angle and the reflection angle do not become extraordinarily large.-

a34

Please substitute the following paragraph for the paragraph starting at page 34, line 14 and ending at line 26. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--As regards the width of the imaging region on the image plane, the mirror should be disposed so as to keep the effective light as much as possible. When the field optical system Grf comprises only a refractive lens system (Figure 3, (A)) or it includes a mirror (Figure 3, (B)), in the first imaging system Gr1, the object height may be made high within the tolerable range of aberration correction. Thus, this is not an obstacle. In the field optical system Grf having a field mirror (Figure 3, (B)), since the width of light is narrow, it is easy to avoid an eclipse of the effective light flux. Therefore, a sufficient imaging region width can be attained.--

a35

Please substitute the following paragraph for the paragraph starting at page 34, line 27 and ending at page 35, line 27. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--In the first imaging system Gr1, a positive lens group G1 may be disposed just after the object plane. This is effective for the correction of distortion aberration, for example, and to maintain its object-side telecentricity satisfactorily. Therefore, in order to reduce any warp of the object plane (reticle) or image plane (wafer) or to decrease a change in magnification due to defocus, it is desirable to provide an optical system being telecentric both in the object side and the image side, by using the positive lens group G1 and the second imaging system Gr2. In the present invention, as shown in Figure 3, the second mirror M2 should have a half disk-like shape, for separation of light. The positive lens group G1 may have either a half disk-like shape, or it may have a disk-like shape for easiness of lens manufacture and lens

a36

holding. Further, the second mirror M2 may be formed at the surface portion below the optical axis. For the same reason, the lens LP1 having a half disk-like shape, may have a disk-like shape. On that occasion, the light passes the lens LP1 three times. Similarly, the second mirror M2 may be formed at the lower surface portion of the lens LP1. Also, the first mirror M1 may be formed as a back-surface mirror of the lens LN1. The mirrors used in the present invention may be back-surface mirrors, with respect to the aberration correction.--

a36 concl

Please substitute the following paragraph for the paragraph starting at page 36, line 17 and ending at line 19. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a37

--When the magnification of the second imaging system Gr2 is BG2, the following relation should be satisfied:--

Please substitute the following paragraph for the paragraph starting at page 36, line 21 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a38

--When the magnification of the first imaging system Gr1 is BG1, the following relation should be satisfied:--

Please substitute the following paragraph for the paragraph starting at page 37, line 11 and ending at line 15. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a39 cont

--When the paraxial distance between the first and second mirrors is LM2, and the paraxial distance from the object plane to the intermediate image by the first imaging system OIL, the distance LM1 described above satisfies the following relation:--

Please substitute the following paragraph for the paragraph starting at page 37, line 20 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a40

--When the distance from the object plane to the image plane with respect to the projection optical system is L, the distance LM1 described above satisfies the following relation:--

Please substitute the following paragraph for the paragraph starting at page 41, line 4 and ending at page 42, line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a41

--Condition (5) concerns the positional relation of the intermediate image by the first imaging system Gr1 and the first mirror M1. Under the condition, the reflection light from the second mirror M2 efficiently passes toward the image side without interference with the first mirror group GM1. As shown in Figure 3, it is preferable that an intermediate image is formed substantially outside the first mirror M1. Thus, if this range is exceeded, the width of light outside the first mirror M1 becomes large, and the diameter of the field optical system Grf becomes large. This causes an increase of aberration. Particularly, if the lower limit is exceeded, the magnification of the first imaging system Gr1 becomes too small, and there may occur an inconvenience of interference of the reflection light from the second mirror M2 with the first

a41 cont

mirror group GM1. Further, the powers of the first and second mirrors M1 and M2 become too large, and the amount of aberration production undesirably increases. If the upper limit is exceeded, to the contrary, the magnification of the first imaging system Gr1 becomes too large. As a result, an excessive space is produced outside the first mirror M1, or the magnification has to be reduced by means of the second imaging system Gr2. Thus, the power balance of the optical system as a whole is undesirably destroyed. The upper limit of the condition (5) may preferably be equal to 3.0.--

Please substitute the following paragraph for the paragraph starting at page 44, line 15 and ending at page 45, line 2. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a42

--Important features of an embodiment such as shown at (B) in Figure 3 reside in that, in the first imaging system Gr1, the above-described function (c) is used twice such that the reflection is performed twice by using two mirrors of the first and second mirrors M1 and M2, and that the light from the object is directed through the outside of the effective diameter of the first mirror group GM1 to the image plane side. Also, even in the field optical system Grf, the above-described function (c) is used twice, and the reflection is made twice by using two mirrors of first and second field mirrors FM1 and FM2, so that the light is directed to the image plane side through the optical axis central portion of the first field mirror FM1.--

Please substitute the following paragraph for the paragraph starting at page 45, line 5 and ending at line 7. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-When the magnification of the first imaging system Gr1 is BG1, the following relation should be satisfied:-

a43

Please substitute the following paragraph for the paragraph starting at page 46, line 20 and ending at page 47, line 11. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a44

-In the second embodiment of the present invention as described above, the optical system comprises a first imaging system, a field optical system and a second imaging system. Two mirrors of the first imaging system are used to perform reflection twice, to direct light to the image plane side. By this, the structure becomes very simple wherein the optical axis extends along a single straight line. Further, when predetermined conditions such as positional relations of the mirrors, and magnification sharing of each imaging system and each mirror group, are satisfied, a sufficient imaging region width is attainable. Thus, a catadioptric projection optical system which is small in size and light in weight, which has optical elements of a reduced number, which has incidence angles and reflection angles on the mirrors not being very large, and which has a sufficient image side working distance, is accomplished.-

Please substitute the following paragraph for the paragraph starting at page 47, line 12 and ending at line 15. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a45

-A specific example of the present invention will now be described. Examples 1 - 4 are those based on the first embodiment described above, and examples 5 - 21 are those based on the second embodiment.-

Please substitute the following paragraph for the paragraph starting at page 48, line 13 and ending at line 17. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a46

--Figure 8 shows longitudinal and transverse aberrations of this example, and structural specifications of a numerical example are shown in Table 1. The aberrations in the drawing concern the base wavelength 157 nm ±2 pm.--

Please substitute the following paragraph for the paragraph starting at page 49, line 1 and ending at line 8. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a47

--The refractive lens group R (reciprocal optical system) comprises an aspherical negative lens of meniscus shape, having a concave surface facing to the object side. With this negative lens, mainly the curvature of field and axial chromatic aberration are corrected. Also, with the aspherical surface, mainly the spherical aberration and coma aberration, for example, are corrected.--

Please substitute the following paragraph for the paragraph starting at page 49, line 9 and ending at line 26. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a48

--The first mirror M1 comprises an aspherical surface concave mirror having a concave surface facing to the object side. It has a positive refracting power and functions to produce a curvature of field in the positive direction to cancel the negative curvature of field of hte second imaging optical system which comprises a refractive lens. The second mirror M2

comprises a concave mirror having a concave surface facing to the image side, and it serves to direct the abaxial light on the first object 101 to the outside of the effective diameter of the first mirror M1. An intermediate image is formed adjacent to the outside of the effective diameter of the first mirror M1. In this example, the first imaging optical system is an enlarging system, and separation between the reflection light from the first mirror M1 and the reflection light from the second mirror M2 is accomplished easily.--

a48 cont

Please substitute the following paragraph for the paragraph starting at page 50, line 3 and ending at line 27. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--The second imaging optical system G2 comprises, in an order from the object side, an aspherical positive lens of meniscus shape having a concave surface facing to the object side, an aperture stop, an aspherical positive lens of approximately flat-convex shape having a convex surface facing to the image side, an aspherical positive lens having a convex surface facing to the object side, an aspherical lens having a concave surface facing to the image side, an aspherical lens having a convex surface facing to the image side, and an aspherical positive lens having a convex surface facing to the object side. The second imaging optical system G2 provides a reduction system for imaging the light from the field lens group F onto the second object surface 102. Because the light is incident on the aperture stop with a certain angle, the effective diameter of the refractive lens about the aperture stop can be suppressed to be small. With this arrangement, various aberrations such as axial chromatic aberration and spherical aberration can be reduced and, additionally, they can be cancelled with various aberrations

a49

a49 cont

produced in the first imaging optical system. Thus, satisfactory aberration correction is accomplished in the whole system.--

Please substitute the following paragraph for the paragraph starting at page 52, line 5 and ending at line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a50

--Figure 9 shows longitudinal and transverse aberrations of this example, and structural specifications of a numerical example are shown in Table 2. The aberrations in the drawing concern the base wavelength and a wavelength ±2 pm.--

Please substitute the following paragraph for the paragraph starting at page 54, line 3 and ending at line 7. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a51

--Figure 10 shows longitudinal and transverse aberrations of this example, and structural specifications of a numerical example are shown in Table 3. The aberrations in the drawing concern the base wavelength 157 mn ±2 pm.--

Please substitute the following paragraph for the paragraph starting at page 54, line 16 and ending at page 55, line 8. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a52

--The first mirror M1 comprises an aspherical surface concave mirror having a concave surface facing to the object side. It has a positive refracting power and functions to produce a curvature of field in the positive direction to cancel the negative curvature of field of

the second imaging optical system which comprises a refractive lens. The second mirror M2 comprises an aspherical surface concave mirror having a concave surface facing to the image side, and it serves to direct the abaxial light on the first object 101 to the outside of the effective diameter of the first mirror M1. An intermediate image is formed adjacent to the outside of the effective diameter of the first mirror M1. In this example, a field lens group F is disposed adjacent to the intermediate image. This field lens group F comprises, in an order from the object side, an aspherical positive lens of meniscus shape having a convex surface facing to the image side, and an aspherical positive lens of biconvex shape.--

a52 cont

Please substitute the following paragraph for the paragraph starting at page 55, line 9 and ending at page 56, line 6. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--The second imaging optical system G2 comprises, in an order from the object side, an aspherical positive lens of meniscus shape having a convex surface facing to the object side, an aperture stop, an aspherical positive lens of approximately flat-convex shape having a convex surface facing to the image side, an aspherical positive lens having a convex surface facing to the object side, aspherical lens having a concave surface facing to the image side, an aspherical lens having a convex surface facing the to the image side, and an aspherical positive lens having a convex surface facing to the object side. The second imaging optical system for imaging the light from the field lens group F onto the second object surface 102. Because the light is incident on the aperture stop with a certain angle, the effective diameter of the refractive lens about the aperture stop can be suppressed to be small. With this arrangement, various aberrations such as axial chromatic aberration and spherical aberration can be reduced and,

a53

a53 cont

additionally, they can be cancelled with various aberrations produced in the first imaging optical system. Thus, satisfactory aberration correction is accomplished in the whole system.--

Please substitute the following paragraph for the paragraph starting at page 56, line 8 and ending at line 11. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a54

--Figure 7 shows a specific lens structure of Example 4. The projection magnification was 1:5, and the design base wavelength was 157 nm (wavelength of an F_2 excimer laser). The glass material was fluorite.--

Please substitute the following paragraph for the paragraph starting at page 56, line 12 and ending at line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a55

--In this embodiment, the image side numerical aperture was NA = 0.60, and the object-to-image distance (from the first object plane to the second object plane) was L = about 1411 mm. In the range of the image height of about 9 - 15 mm, the aberration was corrected. An abaxial exposure region of an arcuate shape, having at least a size of about 20.8 mm in the lengthwise direction and 5 mm in the width was assured.--

Please substitute the following paragraph for the paragraph starting at page 56, line 21 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a56 --Figure 11 shows longitudinal and transverse aberrations of this example, and structural specifications of a numerical example are shown in Table 4.--

Please substitute the following paragraph for the paragraph starting at page 57, line 10 and ending at line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a57 --The first mirror M1 comprises an aspherical surface concave mirror having a concave surface facing to the object side. The second mirror M2 comprises an aspherical surface concave mirror having a concave surface facing to the image side, and it serves to direct the abaxial light on the first object 101 to the outside of the effective diameter of the first mirror M1. An intermediate image is formed adjacent to the outside of the effective diameter of the first mirror M1. In this example, the first imaging optical system G1 constitutes a reduction system.--

Please substitute the following paragraph for the paragraph starting at page 58, line 4 and ending at line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a58 --In the four examples described above, except Example 2, the first mirror M1 is defined by an aspherical surface. Further, except Examples 1 and 2, all the refractive lenses are aspherical lenses. However, a spherical lens may be used in combination.--

Please substitute the following paragraph for the paragraph starting at page 58, line 15 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-In Examples 1 - 4 described above, the exposure region has an arcuate shape. However, as long as it is inside the aberration-corrected range, any other shape such as a rectangular shape may be used. Further, while the group L2 having two mirrors is shown as including the refractive lens group R, the refractive lens group R and the mirrors may be integrated (Mangin mirror structure). Alternatively, the refractive lens group R and the second mirror M2 may be integrated into a Mangin mirror structure.-

a59

Please substitute the following paragraph for the paragraph starting at page 58, line 25 and ending at page 59, line 1. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-In the examples described above, while there is aspherical surface data in which the conical constant k is taken as zero, the design may be made while using the conical constant as a variable.-

a60

Please substitute the following paragraph for the paragraph starting at page 59, line 2 and ending at line 11. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-The exposure light source used an F_2 laser of a wavelength 157 nm. However, a KrF excimer laser (wavelength 248 nm) or an ArF excimer laser (wavelength 193 nm), for example, may be used. Particularly, the invention is effective when the wavelength is shortened and usable optical materials are limited, and the number of optical elements should be reduced. Thus, the present invention is effective for an optical system to be used with a wavelength not longer than 250 nm-

a61

Please substitute the following paragraph for the paragraph starting at page 59, line 12 and ending at line 18. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a62

In these examples, fluorite was used as the glass material for the wavelength 157 nm from the F_2 excimer laser. However, any other glass material such as fluorine-doped quartz, for example, may be used. When a KrF or an ArF light source is used, fluorite and quartz may be used in combination, or only one of them may be used.

Please substitute the following paragraph for the paragraph starting at page 60, line 18 and ending at page 61, line 1. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a63

Structural specifications of numerical examples are shown in Table 5. In this example, an image side working distance of 30 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 224.7 mm. While the largest diameter of the optical system as a whole is 227 mm at the field optical system, the largest diameter of the second imaging system is as small as 125 mm, regardless that the NA is 0.6. Figure 29 shows aberrations, and from this, it is seen that aberrations are corrected satisfactorily.

Please substitute the following paragraph for the paragraph starting at page 62, line 8 and ending at line 18. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a64

Structural specifications of numerical examples are shown in Table 6. In this example, an image side working distance of 31 mm is assured, and the total glass material length

along the optical path is extraordinarily shortened to 232.1 mm. While the largest diameter of the optical system as a whole is 196 mm at the field optical system, the largest diameter of the second imaging system is as small as 143 mm, regardless that the NA is 0.6. Figure 30 shows aberrations, and from this, it is seen that aberrations are corrected satisfactorily.--

a64 cont

Please substitute the following paragraph for the paragraph starting at page 63, line 23 and ending at page 64, line 6. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a65

--Structural specifications of numerical examples are shown in Table 7. In this example, an image side working distance of 31 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 333.8 mm. While the largest diameter of the optical system as a whole is 250 mm at the field optical system, the largest diameter of the second imaging system is as small as 143 mm, regardless of the NA is 0.6. Figure 31 shows aberrations, and from this, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 65, line 13 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a66

--Structural specifications of numerical examples are shown in Table 8. In this example, an image side working distance of 36. 1 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 337.6 mm. While the largest diameter of the optical system as a whole is 245 mm at the field optical system, the largest

diameter of the second imaging system is as small as 142 mm, regardless that the NA is 0.6. Figure 32 shows aberrations, and from this, it is seen that aberrations are corrected satisfactorily.--

a64 cont

Please substitute the following paragraph for the paragraph starting at page 67, line 14 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a67

--Structural specifications of numerical examples are shown in Table 9. In this example, an image side working distance of 30.3 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 400.5 mm. While the largest diameter of the optical system as a whole is 213 mm at the field optical system, the largest diameter of the second imaging system is as small as 157 mm, regardless that the NA is 0.6. Figure 33 shows aberrations, and from this, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 69, line 9 and ending at line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a68

--Structural specifications of numerical examples are shown in Table 10. In this example, an image side working distance of 30.0 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 375.9 mm. While the largest diameter of the optical system as a whole is 266 mm at the field optical system, the largest diameter of the second imaging system is as small as 105 mm, regardless that the NA is 0.6.

Figure 34 shows aberrations with respect to the base wavelength 157 nm and a wavelength range

a68 cont

of 2 pm. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 71, line 2 and ending at line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a69

--Structural specifications of numerical examples are shown in Table 11. In this example, an image side working distance of 30.0 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 371.9 mm. While the largest diameter of the optical system as a whole is 328 mm at the field optical system, the largest diameter of the second imaging system is as small as 141 mm, regardless that the NA is 0.6. Figure 35 shows aberrations with respect to the base wavelength 157 nm and a wavelength range of 2 pm. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 72, line 9 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a70

--Denoted at r13 - r20 are components of a field optical system Grf, and it comprises three positive lenses, including a positive lens FL1 of doughnut shape, being hollow at its center, and being disposed outside the first mirror M1, and one negative lens. Denoted at r21 - r31 are components of a second imaging system Gr2, and it comprises a stop r25, four positive lenses and one negative lens.--

Please substitute the following paragraph for the paragraph starting at page 72, line 17 and ending at page 73, line 8. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--In this example, since the pupil conjugate point of the first imaging system Gr1 is placed closer to the object side, a value close to the lower limit of condition (4) is taken. Further, like Example 10, due to the structure of the first mirror group GM1 as described, the effect of correcting chromatic aberration is enhanced. Also, the positive lens FL1 of the field optical system Grf is made into a doughnut shape, and the first mirror group GM1 of the first imaging system Gr1 is disposed at the central portion of the doughnut shape. With this structure, the light rays can be refracted at a position closer to the object side and, therefore, the powers of the field optical system Grf and the second imaging system Gr2 can be made smaller. This is very advantageous with respect to the aberration correction. Further, the second mirror group GM2 is provided by the positive lens LP1 and the second mirror M2, to thereby control the Petzval sum.--

a71

Please substitute the following paragraph for the paragraph starting at page 73, line 9 and ending at line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Structural specifications of numerical examples are shown in Table 12. In this example, an image side working distance of 30.0 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 377.0 mm. While the largest diameter of the optical system as a whole is 328 mm at the field optical system, the largest diameter of the second imaging system is as small as 144 mm, regardless that the NA is 0.6.

a72

a72 cont

Figure 36 shows aberrations with respect to the base wavelength 157 nm and a wavelength range of 2 pm. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 74, line 20 and ending at page 75, line 3. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a73

--Structural specifications of numerical examples are shown in Table 22. In this example, an image side working distance of 30.0 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 192.2 mm. While the largest diameter of the optical system as a whole is 388 mm at the field optical system, the largest diameter of the second imaging system is as small as 167 mm, regardless that the NA is 0.6. Figure 37 shows aberrations. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 76, line 11 and ending at line 21. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a74

--Structural specifications of numerical examples are shown in Table 14. In this example, an image side working distance of 30 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 156.4 mm. While the largest diameter of the optical system as a whole is 444 mm at the field optical system, the largest diameter of the second imaging system is as small as 144 mm, regardless that the NA is 0.6.

Figure 38 shows aberrations. From the drawing, it is seen that aberrations are corrected

a74 cont satisfactorily.

Please substitute the following paragraph for the paragraph starting at page 76, line 23 and ending at page 77, line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a75 Figure 22 is an optical path view of Example 15 of the present invention. The design base wavelength was 157 nm of F_2 excimer laser light, the NA was 0.6, and the projection magnification β was 1:4. The lens conjugate distance L was 1190 mm. The optical system had an exposure region (imaging region) upon an image plane, of an arcuate shape, at the image height from 9.56 mm to 13.65 mm. The optical system was provided by use of four mirrors and eight lenses (two lenses added to Example 13).

Please substitute the following paragraph for the paragraph starting at page 78, line 8 and ending at line 19. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a76 Structural specifications of numerical examples are shown in Table 15. In this example, an image side working distance of 36 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 203.7 mm. While the largest diameter of the optical system as a whole is 512 mm at the field optical system, the largest diameter of the second imaging system is as small as 146 mm, regardless that the NA is 0.6. Figure 39 shows aberrations with respect to the base wavelength 157 nm and a wavelength range of 4 pm. From the drawing, it is seen that aberrations are corrected satisfactorily.

Please substitute the following paragraph for the paragraph starting at page 80, line 3 and ending at line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Structural specifications of numerical examples are shown in Table 16. In this example, an image side working distance of 36 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 292.8 mm. While the largest diameter of the optical system as a whole is 294 mm at the field optical system, the largest diameter of the second imaging system is as small as 184 mm, regardless that the NA is 0.6. Figure 40 shows aberrations. From the drawing, it is seen that aberrations are corrected satisfactorily.--

a17

Please substitute the following paragraph for the paragraph starting at page 80, line 15 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Figure 24 is an optical path view of Example 17 of the present invention. The design base wavelength was 157 nm of F_2 excimer laser light, the NA was 0.6, and the projection magnification β was 1:4. The lens conjugate distance L. was 1188 mm. The optical system had an exposure region (imaging region) upon an image plane, of an arcuate shape, at the image height from 9.56 mm to 13.65 mm. The optical system was provided by use of four mirrors and nine lenses.--

a18

Please substitute the following paragraph for the paragraph starting at page 82, line 6 and ending at line 18. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a79

--Structural specifications of numerical examples are shown in Table 17. In this example, an image side working distance of 36 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 303.3 mm. While the largest diameter of the optical system as a whole is 323 mm at the field optical system, the largest diameter of the second imaging system is as small as 125 mm, regardless that the NA is 0.6. Figure 41 shows aberrations, with respect to the base wavelength 157 nm and a wavelength range of 2 pm. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 83, line 24 and ending at page 84, line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a80

--Structural specifications of numerical examples are shown in Table 18. In this example, an image side working distance of 37 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 286.8 mm. While the largest diameter of the optical system as a whole is 442 mm at the field optical system, the largest diameter of the second imaging system is as small as 165 mm, regardless that the NA is 0.6. Figure 42 shows aberrations, with respect to the base wavelength 157 nm and a wavelength range of 4 pm. From the drawing, it is seen that the aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 85, line 7 and ending at line 18. A marked-up copy of this paragraph, showing the changes made thereto is attached.

-In this example, with the use of the first mirror group GM1 as provided by the negative lens LN1 and the first mirror M1, color correction is accomplished. Further, with the use of the second field mirror group GFM 2 which is provided by the second field mirror FM2 (convex) and the positive lens LF, the Petzval sum is also controlled. Since the magnification of the first imaging system Gr1 is at the most reduction rate, a value close tothe upper limit of condition (9) is taken. Since the spacing between the second and first field mirrors FM2 and FM1 is relatively small, a value close to the lower limit of condition (14) is taken.-

a81

Please substitute the following paragraph for the paragraph starting at page 85, line 19 and ending at page 86, line 4. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Structural specifications of numerical examples are shown in Table 19. In this example, an image side working distance of 33.7 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 264.4 mm. Further, the largest diameter of the whole optical system is very short, as small as 293 mm, and also the largest diameter of the second imaging system is as small as 130 mm, regardless that the NA is 0.6. Figure 43 shows aberrations, with respect to the base wavelength 157 nm and a wavelength range of 2 pm. From the drawing, it is seen that aberrations are corrected satisfactorily.--

a82

Please substitute the following paragraph for the paragraph starting at page 87, line 3 and ending at line 20. A marked-up copy of this paragraph, showing the changes made thereto is attached.

In this example, since the magnification of the first imaging system Gr1 is strongly enlarged, a value close to the lower limit of condition (9) is taken. This is because the magnification of the first mirror group GM1 is positive, and because a value close to the upper limit of condition (13) is taken. As a result, a value close to the upper limit of condition (11) is taken, and the position of the intermediate image produced by the first imaging system Gr1 is far remote from the first mirror M1. Further, since the pupil conjugate point of the first imaging system Gr1 is at the image plane side with respect to the first mirror M1, a value close to the upper limit of condition (10) is taken. Additionally, with the use of the second field mirror group GFM2 which is provided by the second field mirror FM2 (convex) and the negative lens LF, the Petzval sum is also controlled.

a83

Please substitute the following paragraph for the paragraph starting at page 87, line 21 and ending at page 88, line 4. A marked-up copy of this paragraph, showing the changes made thereto is attached.

Structural specifications of numerical examples are shown in Table 20. In this example, an image side working distance of 36 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 315.5 mm. While the largest diameter of the optical system as a whole is 355 mm at the field optical system, the largest diameter of the second imaging system is as small as 177 mm, regardless that the NA is 0.6.

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a84 cont

Figure 44 shows aberrations. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 88, line 6 and ending at line 15. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a85

--Figure 28 is an optical path view of Example 21 of the present invention. The design base wavelength was 157 nm of F_2 excimer laser light, the NA was 0.6, and the projection magnification β was 1:10. The lens conjugate distance L was 1190 mm. The optical system had an exposure region (imaging region) upon an image plane, of an arcuate shape, at the image height from 9.56 mm to 13.65 mm. The optical system was provided by the use of four mirrors and nine lenses, like Example 16.--

Please substitute the following paragraph for the paragraph starting at page 89, line 3 and ending at line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a86

--In this example, the magnification of the second imaging system Gr2 has a value close to the lower limit of condition (1). Also, the distance between the second and first mirrors M2 and M1 is short, and a value close to the lower limit of condition (6) is taken. Further, with the use of the first mirror group GM1 being provided by the negative lens LN1 and the first mirror M1 as well as the second field mirror group GFM2 which is provided by the second field mirror FM2 (convex) and the negative lens LF, the Petzval sum is also controlled.--

Please substitute the following paragraph for the paragraph starting at page 89, line 14 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a87

--Structural specifications of numerical examples are shown in Table 21. In this example, an image side working distance of 36 mm is assured, and the total glass material length along the optical path is extraordinarily shortened to 301.7 mm. While the largest diameter of the optical system as a whole is 310 mm at the field optical system, the largest diameter of the second imaging system is as small as 180 mm, regardless that the NA is 0.6. Figure 45 shows aberrations. From the drawing, it is seen that aberrations are corrected satisfactorily.--

Please substitute the following paragraph for the paragraph starting at page 89, line 25 and ending at page 90, line 12. A marked-up copy of this paragraph, showing the changes made thereto is attached.

a88

--In Examples 5 - 21 described above, aspherical surface are used and, among the aspherical surfaces used, there are lens surfaces having a conical constant k set to zero. However, design may be made while taking the conical constant k as a variable. Further, in these examples, the wavelength of an F_2 excimer laser was used as a design wavelength, and fluorite (n = 1.5600) was used as the glass material for it. However, any other glass material such as fluorine-doped quartz, for example, may be used. When a KrF or an ArF light source is used, fluorite and quartz may be used in combination. Alternatively, only one of them may be used and, on that occasion, since the dispersion of glass material is smaller, the correction of chromatic aberration becomes easier.--

Please substitute the following paragraph for the paragraph starting at page 90, line 13 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--A projection optical system according to these examples may be used as a projection optical system in a scan type projection exposure apparatus for projecting a pattern (device pattern such as a circuit pattern) of a reticle or a mask onto a substrate or a wafer in accordance with a step-and-scan procedure. A wafer is exposed to a device pattern by use of such an exposure apparatus, and then, the exposure wafer is developed. Through subsequent processes such as etching, devices (semiconductor chips) are produced.--

a89

IN THE ABSTRACT:

Please substitute the following Abstract for the Abstract starting at page 123, line 2 and ending at line 17. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--A projection optical system projects an image of an object onto an image plane, and includes a first imaging optical system for forming an image of the object, and a second imaging optical system for re-imaging the image upon the image plane, wherein the first and second imaging optical systems are disposed in an order from the object side and are disposed along a common straight optical axis. The first imaging optical system includes a first mirror for reflecting and collecting abaxial light from the object, wherein one of the first and second imaging optical systems includes a second mirror for reflecting light from the first mirror to the image plane side, and wherein, with the second mirror, the abaxial light is caused to pass an outside of an effective diameter of the first mirror.--

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